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NAVAL POSTGRADUATE SCHOOL

Monterey, California



ANALYSIS OF RESPONSES TO THE STUDENT OPINION FORM

Ronald A. Weitzman

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Monterey, California

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13. ABSTRACT (Maximum 200 words) <p>Student Opinion Form data on 1,610 classes taught in the Department of Administrative Sciences between 1983 and 1990 were subjected to SAS analyses employing principally the General Linear Model procedure. The independent variables included Faculty (identified by the two-letter mail code) and Course (e.g., MN3111), and the dependent variable was Mean Item 12 (opinion of instructor, measured on a 5-point scale).</p> <p>The principal results were that Course and Faculty accounted for 66% of the variation in Mean Item 12, with Course accounting for 35% and Faculty for the remaining 31%. Class Size and Majority Curriculum, by contrast, together accounted for considerably less than 1%.</p> <p>A major implication of these results is that the appropriate bench mark for comparison in evaluating an instructor's effectiveness in class is not the overall average (across all classes) of 4.03 on Mean Item 12 but the average for the course taught. Mean Item 12 averages are presented for all 131 Administrative Sciences courses in the data set.</p>					
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ANALYSIS OF RESPONSES TO THE STUDENT OPINION FORM

Department of Administrative Sciences 1983-1990

Abstract

Student Opinion Form data on 1,610 classes taught in the Department of Administrative Sciences between 1983 and 1990 were subjected to SAS analyses employing principally the General Linear Model procedure. The independent variables in the analyses were, for each class, Faculty (identified by the two-letter mail code), Course (e.g., MN 3111), Majority Curriculum (e.g., 847), Class Size, Mean Item 13 (student opinion of course, measured on a 5-point scale), and Proportion for Whom Required (the proportion of students in class required to take the course). The dependent variable was Mean Item 12 (student opinion of instructor, measured on a 5-point scale).

The principal results were that Course and Faculty accounted for 66% of the variation in Mean Item 12, with Course accounting for 35% and Faculty for the remaining 31%. Different from previous studies of the SOF, neither Class Size nor Majority Curriculum accounted for a notable percentage in the variation of Mean Item 12. The two together, in fact, accounted for considerably less than 1%.

A major implication of these results is that the appropriate bench mark for comparison in evaluating an instructor's effectiveness in class is not the overall average (across all classes) of 4.03 on Mean Item 12 but the average for the course taught. The average for a course might vary considerably from the overall average. This report presents the Mean Item 12 averages for all 131 Administrative Sciences courses represented in the data set.

ANALYSIS OF RESPONSES TO THE STUDENT OPINION FORM

Department of Administrative Sciences 1983-1990

Summary

Student Opinion Form data on 1,610 classes taught in the Department of Administrative Sciences between 1983 and 1990 were subjected to SAS analyses employing principally the General Linear Model procedure. The independent variables in the analyses were, for each class, Faculty (identified by the two-letter mail code), Course (e.g., MN 3111), Majority Curriculum (e.g., 847), Class Size, Mean Item 13 (student opinion of course, measured on a 5-point scale), and Proportion for Whom Required (the proportion of students in class required to take the course). The dependent variable was Mean Item 12 (student opinion of instructor, measured on a 5-point scale).

Results were that Course and Mean Item 13, along with Faculty, accounted for most of the variation in Mean Item 12. Incrementally, Mean Item 13 accounted for 79%, Course for 6%, and Faculty for 5% of this variation. Course and Faculty alone accounted for 66%, with Course accounting for 35% and Faculty for the remaining 31%. Different from previous studies of the SOF, neither Class Size nor Majority Curriculum accounted for a notable percentage in the variation of Mean Item 12. The two together, in fact, accounted for considerably less than 1%.

Implications of these results are at least twofold. The first is that class size, particularly near the mean of 20.6 students for these data, need not be a consideration in school instructional policy. The second is that the appropriate benchmark for comparison in evaluating an instructor's effectiveness in class is not the overall average (across all classes) of

4.03 on Mean Item 12 but the average for the course taught. The average for a course might vary considerably from the overall average. This report presents the Mean Item 12 averages for all 131 Administrative Sciences courses represented in the data set.

Since studies of SOF data for other departments are likely to lead to comparable results, particularly different Mean Item 12 averages for different courses, the school should authorize these studies to provide the course or other bench marks needed for appropriate evaluation of instructional effectiveness throughout the school.

ANALYSIS OF RESPONSES TO THE STUDENT OPINION FORM

Department of Administrative Sciences 1983-1990

Background

To facilitate instruction, the Naval Postgraduate School has since 1977 administered to its students a Student Opinion Form (SOF) developed from a form created by Educational Testing Service and used earlier at the school. The original purpose of these forms was to provide feedback to instructors. Subsequently the purpose has expanded to include evaluation of instruction for pay, promotion, and tenure decisions.

The SOF contains 16 items that require responses on a five-point scale, with 1 the lowest value and 5 the highest value. Items 1 to 11 refer to specific aspects of instruction. Item 12 requests overall evaluation of the instructor, and Item 13 requests overall evaluation of the course. The remaining items refer to the textbooks and other possible aspects of the course. Exhibit 1 shows these 16 items as they appear on the form. Item 12--particularly the mean for each class, called Mean Item 12 in this report--receives most attention from instructors and administrators.

In addition to these items, the SOF requests information about the student's curriculum and, for each student, the elective status of the course (required or not). Summary information for each class indicates the number of students in the class who completed the form.

At the end of each academic term, the school separates the response data from the instructor and course information and stores the response data in computer-accessible form at the school's computer center. Each department head receives the

instructor and course information on a SOF-transmittal sheet that also contains summary information describing the response data for each class. The only link between the response data stored at the computer center and the instructor and course information on the SOF-transmittal sheet is the Student Opinion Form number (SOF number) assigned to the class. These numbers vary from instructor to instructor and from course to course over successive school terms. Their range varies from department to department. For the Department of Administrative Sciences, the SOF numbers range from 140 to 219.

Different departments at the school have from time to time conducted studies of the SOF data. Professor Robert R. Read (1979) published a study of SOF responses by students in probability and statistics classes. This study showed that course and curriculum accounted for more variation in Mean Item 12 (overall evaluation of instructor) than faculty did. A contemporaneous study by Joel Weston Aiken (1979), one of Professor Read's students, showed within the Operations Research Department that class size also affected Mean Item 12 responses, larger classes being accompanied by lower response values. In a thesis study involving 28 Administrative Sciences classes (for which complete data were available) and extending over two academic terms, Vivian G. Melidosian and Carol A. White (1984) partly confirmed these earlier findings, particularly with respect to the substantial effects on Mean Item 12 responses of curriculum and class size, as well as faculty. The Melidosian and White study, which also indicated that the number of years an instructor has been on the NPS faculty had a notable effect on Mean Item 12 responses, included a large bibliography on student evaluation of

nstruction.

The study reported here is an extension of these earlier studies. The data represent 1,610 classes offered by the Department of Administrative Sciences from Winter Quarter of 1983 to Summer Quarter of 1990, with Summer Quarter of 1984 missing because of loss of the SOF-transmittal-sheet information for that quarter. Incomplete data also resulted in the omission of 46 from the originally 1,656 classes of this eight-year data set.

Construction of the Data Set

The SOF-transmittal-sheet information--the SOF summary information provided each department head following every quarter--consists of one line per class. This line contains the name of the instructor, the name of the course, and the SOF number, among other information. The response data stored at the computer center consists of one line per student. This line contains the student's numerical responses to Items 1 to 16, the student's curriculum number, the elective status of the course for the student, the quarter and year of the class, and the class's SOF number, among other information.

Construction of the data set began with the summarization of the response data for each class. A FORTRAN program, presented in Appendix A, carried out this summarization. The result was a line for each class that contained the SOF number, an identification of each of the first eleven items showing its rank (to be explained later), Mean Over 11 (the mean student response, on a 5-point scale, to the first eleven items over all the students in class), Mean Item 12 (the class mean of student responses to Item 12, overall evaluation of the instructor, measured on a 5-point scale), Standard Deviation of

Item 12 (the standard deviation of the Item 12 responses within the class), Median Item 12 (the median of the class's Item 12 responses), Mean Item 13 (the class mean of student responses to Item 13, overall evaluation of the course, measured on a 5-point scale), Majority Curriculum (the curriculum number for the majority of the students in class, e.g., 847), Proportion for Whom Required (the proportion of students for whom the course was required), and the Quarter (e.g., SUM for summer quarter) and Year (e.g., 83 for 1983) of the class. Eleven columns contained the rank information for the first eleven items. The item "number" of the item that had the highest mean rating in the class appeared in the first of these columns; this was a numeral from 1 to 9 for one of the first nine items, 0 for Item 10, and * for Item 11. The "number" of the item that had the second highest mean rating appeared in the second of the eleven columns, and so on to the last of these columns, which contained the "number" of the item that had the lowest mean rating in the class. The sequence of "numbers" in these eleven columns represents a sort of instructional "fingerprint" for an instructor.

As a result of the FORTRAN processing of the raw response data, a separate file now contained the response summaries for all the classes taught in each quarter and year, one file for each successive quarter in the eight-year period. The next task was to construct a corresponding file from the SOF-transmittal-sheet information. This file would contain for each class taught in the quarter the SOF number and the faculty and course designations: Faculty, identified by the two-digit mail code (e.g., WZ), and Course (e.g., MN 3111). Administrative Sciences Department staff constructed these

files. The final task was to join them with the response-summary files for each class. Using the SOF number as a link, a SAS program, presented in Appendix B, performed this task. The result was a single file of 1,610 lines containing SOF information for most of the classes taught in the Administrative Science Department between 1983 and 1990. Exhibit 2 shows a number of lines of this file, with faculty identification omitted to assure anonymity. (In this exhibit, IDSOF refers to SOF number, IDPROF to Faculty, IDCOURSE to Course, NSTUDENT to Class Size, CURR to Majority Curriculum, MEAN11 to Mean Over 11, MEAN12 to Mean Item 12, STD12 to Standard Deviation of Item 12, MED12 to Median Item 12, MEAN13 to Mean Item 13, REQD to Proportion for Whom Required, and QTRYR to the quarter and the calendar year of the class.)

Analysis of the Data

The data represented not only 1,610 classes but also 151 faculty members, 131 courses, and 23 curricula. Exhibit 3 describes the quantitative variables, exclusive of year. Notable among these is Class Size (more precisely, the number of students who completed the SOF in each class). The mean Class Size was 20.6, and the standard deviation was 8.76. Exhibit 4 shows the intercorrelations among the quantitative variables, including year.

Exhibit 5 shows the frequency distribution of Mean Item 12 for all 1,610 classes in the data set. The distribution is skewed substantially to the left. Comparison of the class averages of Mean Item 12 and Median Item 12 in Exhibit 3--4.03 and 4.10, respectively--indicates a similar skewness of the distributions of Mean Item 12 within classes.

A. Analysis of Quantitative Variables

The first analysis focused on the quantitative variables only. The procedure used was the SAS PROC REG with Mean Item 12 the dependent variable and Mean Item 13, Class Size, Year, and Proportion for Whom Required the independent variables. Exhibit 6 shows the results. Whereas Mean Item 13 accounted for 79% of the variation in Mean Item 12, the other three variables together accounted for considerably less than 1%. Statistically, however, all independent variables were significant with $p < .002$ except for Class Size, which was significant with $p < .02$. Mean Item 12 decreased by .01 for each successive year, increased (a surprise) by .01 for each 10% increase in the number of students required to take the class, and increased (another surprise) by .01 for each increase of five students in class size. The effects of Proportion for Whom Required and Class Size are surprising not only because of their direction but also because of their magnitude. In contrast to these relatively modest effects, an increase in Mean Item 13 of 1.00 resulted in an increase of .95 in Mean Item 12.

The apparent directional anomalies for Class Size and Proportion for Whom Required are due to the presence of Mean Item 13 as a "dominant" variable in the regression. The following formula, for standardized variables, shows the effect on a slope coefficient for one independent variable (indexed by 1) of adding another independent variable (indexed by 2) to a regression:

$$\beta_1 = r_{D1} - \beta_2 r_{12} \quad ,$$

where D refers to Mean Item 12 (the dependent variable).

Consider in this formula that r_{D1} is the slope coefficient for Class Size (variable 1) before the addition of Mean Item 13

(variable 2) and that β_1 is the slope coefficient for Class Size afterwards, when β_2 is the slope coefficient of Mean Item 13. In this case, even though r_{D1} is actually negative (-.16, as indicated in Exhibit 4), β_1 can turn out to be positive (in fact, .002, as Exhibit 6 shows) because β_2 is positive (.95, as Exhibit 6 also shows) and r_{12} is negative (-.23, as indicated in Exhibit 4). The same reasoning applies to Proportion for Whom Required with its simple correlation of -.24 with Mean Item 12 (as shown in Exhibit 4) despite its slope coefficient of .001 in the multiple regression involving Mean Item 13 (see Exhibit 6). In this multiple regression, Mean Item 13 carries the negative effects of Proportion for Whom Required and Class Size because of its own negative correlation with each of these two variables and its dominating positive correlation with Mean Item 12.

B. Analysis of Categorical Variables

Because the data involved a mixture of quantitative and categorical variables that were intercorrelated, the analytical tool for the remaining analyses was the SAS GLM (General Linear Model) procedure. Along with perhaps other independent variables, quantitative or categorical, this procedure enters a categorical variable into a regression analysis as a sequence of dummy (0-1) variables equal in number to one less than the number of categories. The results show the portions of total variation due to error (residual sum of squares), due to the model (regression sum of squares), due incrementally to each independent variable as it enters the analysis (Type I Sum of Squares), and due to the residual part of each independent variable in its regression on the other independent variables in the analysis (Type III Sum of Squares). Included optionally

among the results are dependent-variable means for all values or for all combinations of values of the categorical variables. In all GLM analyses conducted, the dependent variable was Mean Item 12.

The first GLM analysis involved Faculty (e.g., WZ), Course (e.g., MN 3111), and Majority Curriculum (e.g., 847) as the independent variables. This analysis showed that for these data, different from the data analyzed in previous studies, Majority Curriculum did not account for a statistically significant portion of the variation in Mean Item 12 ($p > .05$). Faculty and Course did, however, account for a significant portion of the total variation ($p < .0001$).

The second GLM analysis involved only Faculty and Course as independent variables. This analysis entered Course first in the regression. Exhibits 7 and 8 show the results. In the pie chart (Exhibit 8), which is based on the table in Exhibit 7, the Faculty portion represents the variation in Mean Item 12 due to Faculty alone, the Course portion represents the variation in Mean Item 12 due to Course alone, and the "Common" (white) portion represents the variation due in common to both. (This common variation reflects the interrelationship between Faculty and Course: A faculty member tends to teach some courses, but not others.) Exhibit 7 reveals that, together, Faculty and Course accounted for 66% of the variation in Mean Item 12 ($R^2 = .66$) and that, separately (see the Type III SS column), Faculty accounted for 31% ($100 \times 254/825$) and Course for 8% ($100 \times 63/825$). As the Type I SS column in Exhibit 7 shows, however, Course prior to the entry of Faculty accounted for 35% of the variation in Mean Item 12 ($100 \times 288/825$) while Faculty incrementally accounted for only 31% ($100 \times 254/825$).

These two percentages, 35% and 31%, add up to the total percentage (66%) of the variation in Mean Item 12 accounted for by both Faculty and Course.

C. Analysis of Quantitative and Categorical Variables

The importance of the 35% variation due to Course is that Course is not student opinion of course, which is Mean Item 13. Course and Mean Item 13, however, have a moderately strong correlation (or "correlation ratio," since one of the variables is categorical): .63. Student opinion of a course does indeed vary with the course. The third GLM analysis involved Mean Item 13, entered first, along with Course and Faculty as independent variables. The three variables together accounted for 90% of the variation in Mean Item 12 ($R^2 = .90$). Exhibits 9 and 10 show the results. Whereas separately, as shown in Exhibit 10(a), Mean Item 13 accounted for 24%, Course for 2%, and Faculty for 5%, incrementally (starting from zero), as shown in Exhibit 10(b), Mean Item 13 accounted for 79%, Course for 6%, and Faculty for 5%. The three incremental percentages --79%, 6%, and 5%--add up to the total percentage (90%) of the variation in Mean Item 12 accounted for by Mean Item 13, Course, and Faculty together.

Implications

These results suggest that the instructor alone (Faculty), independently of the course (Course) and the student opinion of the course (Mean Item 13), may account for little variation (5%) in the overall evaluation of the instructor (Mean Item 12). Different from Mean Item 13, which likely has a causally reciprocal relationship with Mean Item 12, Course is arguably an "exogenous" variable, having only a unidirectional causal effect on Mean Item 12. The practical implication of these

results is that an instructor's Mean Item 12 for a class be measured, not against the average Mean Item 12 for all classes, but against the average Mean Item 12 for the course taught.

The average Mean Item 12 for all 1,610 classes in the data set is 4.03. Measured against this standard, an instructor with a Mean Item 12 of 3.65 might not fare so well. What if the course taught were MN 3172 which, for 44 classes, has an average Mean Item 12 of 3.54? Measured against this (the appropriate) standard, the instructor is seen to have performed notably above average. Appendix 3 shows the average Mean Item 12 values for the 131 courses taught in the Department of Administrative Sciences between 1983 and 1990.

The results reported here have at least one other implication. Class size does not seem to affect the overall evaluation of an instructor to any notable extent. The implication of this finding seems to be that the school need not seek to reduce class size in efforts to improve instruction or, at least, reported student perception of instructional quality. This implication, of course, applies to the range of class sizes in the data set (from 2 to 86, with a mean of 20.6 students). For a different range, particularly for a range with a higher mean, the finding might be quite different.

SOF studies in departments other than Administrative Sciences, likely to lead to comparable results, may be necessary to assure appropriate evaluation of instructional effectiveness throughout the school.

References

1. Aiken, J. W., Development of Cluster Analysis Methods Suitable for Student Opinion Data, Master's Thesis, Naval Postgraduate School, Monterey, California, 1979.
2. Melidosian, V. G., & White, C. A., Student-Faculty Evaluation: What Place in Academe? Master's Thesis, Naval Postgraduate School, Monterey, California, 1984.
3. Read, R. R., "Components of Student-Faculty Evaluation Data," Educational and Psychological Measurement, v. 39, pp. 353-360, 1979.

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FOR ME THIS COURSE IS:	
REQUIRED.....	1
ELECTIVE.....	0



	STRONGLY AGREE	AGREE	NO STRONG OPINION	DISAGREE	STRONGLY DISAGREE	NO COMMENT
1 The course was well organized	5	4	3	2	1	0
2 Time in class was spent effectively	5	4	3	2	1	0
3 The instructor seemed to know when students didn't understand the material	5	4	3	2	1	0
4 Difficult concepts were made understandable	5	4	3	2	1	0
5 I had confidence in the instructor's knowledge of the subject	5	4	3	2	1	0
6 I felt free to ask questions	5	4	3	2	1	0
7 The instructor was prepared for class	5	4	3	2	1	0
8 The instructor's objectives for the course have been made clear	5	4	3	2	1	0
9 The instructor made this course a worthwhile learning experience	5	4	3	2	1	0
10 The instructor stimulated my interest in the subject area	5	4	3	2	1	0
11 The instructor cared about student progress and did his share in helping us to learn	5	4	3	2	1	0

PLEASE USE THE FOLLOWING SCALE FOR THE NEXT FIVE ITEMS.

	5 Outstanding (Among the top 10%)	4 Excellent (Among the top 30%)	3 About Average (Middle 40%)	2 Fair (In the lowest 30%)	1 Poor (In the lowest 10%)	0 Not Applicable, Don't know, There were none
12 Overall, I would rate this instructor	5	4	3	2	1	0
13 Overall, I would rate this course	5	4	3	2	1	0
14 Overall, I would rate the textbook(s)	5	4	3	2	1	0
15 Overall, I would rate the quality of the exams	5	4	3	2	1	0
16 Overall, I would rate the laboratories	5	4	3	2	1	0

FOR THE STUDENT THIS IS IMPORTANT DATA

AFTER ALL GRADES HAVE BEEN TURNED IN TO THE REGISTRAR, THE COMMENTS AND A STATISTICAL SUMMARY OF THE INFORMATION FROM THESE FORMS WILL BE RETURNED TO THE INSTRUCTOR FOR COURSE EVALUATION AND TEACHING IMPROVEMENT PURPOSES. THE STATISTICAL SUMMARY WILL ALSO BE USED BY THE ADMINISTRATION FOR EVALUATION OF TEACHING EFFECTIVENESS.

DATA OBTAINED UNDER AUTHORITY OF 5 USC 301.

17	5	4	3	2	1	0
18	5	4	3	2	1	0
19	5	4	3	2	1	0
20	5	4	3	2	1	0

* * * PLEASE USE SPACE ON REVERSE SIDE FOR COMMENTS. * * *

OBS	ID S OF	ID P R OF	ID C O U R S E	N S T U D E N T S E G M E N T	C U R R	R A N K S	M E A N 1	M E A N 1 2	S T D 1 2	M E D 1 2	M E A N 1 3	R E Q D	Q T R Y R
1	140		AS3611	0 29	360	0218*463975	4.60	4.76	0.43	4.84	4.10	1.00	FAL83
2	141		MN4154	2 24	837	0942183*675	4.44	4.42	0.64	4.50	3.58	0.88	FAL83
3	142		MN4154	1 23	837	04239*81765	3.92	3.70	0.95	3.78	3.43	0.70	FAL83
4	150		AS3501	1 11	610	209843*1675	3.88	3.64	0.77	3.75	3.45	0.73	FAL83
5	153		AS3501	2 35	365	4230819*765	4.06	4.06	0.75	4.07	3.77	0.97	FAL83
6	155		CM4925	0 18	620	8324*109756	4.50	4.50	0.69	4.68	4.11	0.72	FAL83
7	156		IS2000	0 46	367	89*32104675	3.31	3.04	1.18	3.03	3.02	0.98	FAL83
8	157		IS3171	0 32	367	3409281*675	3.82	3.91	0.88	3.96	3.19	0.78	FAL83
9	158		IS3183	1 31	837	09284*13756	4.13	4.00	0.88	4.07	3.16	0.97	FAL83
10	159		IS3183	2 30	847	0924381*576	4.17	4.13	0.62	4.11	3.30	0.90	FAL83
11	160		IS3186	1 2	847	*0987654321	5.00	5.00	0.00	5.00	5.00	0.00	FAL83
12	161		IS4183	0 17	367	4098251*736	3.76	3.76	0.88	3.75	3.29	0.47	FAL83
13	162		IS4185	1 19	367	41238*90756	4.38	4.47	0.99	4.77	4.21	0.56	FAL83
14	163		IS4185	2 17	367	41823*09765	4.57	4.71	0.75	4.89	4.18	0.53	FAL83
15	164		IS4200	1 23	368	093*4281576	3.90	3.57	0.71	3.55	3.22	0.86	FAL83
16	165		IS4200	2 19	368	920438*1576	4.21	4.11	0.72	4.11	3.72	0.89	FAL83
17	166		MN1501	0 9	360	*2031846975	4.28	4.44	0.68	4.60	3.89	0.29	FAL83
18	167		MN2106	0 7	620	841032*9765	4.18	4.29	0.45	4.20	3.43	0.86	FAL83
19	168		MN2155	1 31	367	304*8629175	4.00	3.94	0.84	3.96	3.55	0.93	FAL83
20	169		MN2155	2 27	367	04389*62175	4.40	4.52	0.57	4.60	4.04	0.96	FAL83
21	170		MN3001	0 11	857	32471098*65	3.78	3.36	1.07	3.60	3.55	0.90	FAL83
22	171		MN3105	1 22	367	8921043*756	4.12	3.95	0.93	4.05	3.55	0.90	FAL83
23	172		MN3105	2 26	367	891203*4765	3.90	3.77	0.89	3.80	3.23	0.96	FAL83
24	173		MN3105	3 30	367	643280*9157	4.56	4.80	0.40	4.88	4.33	0.96	FAL83
25	174		MN3105	4 23	817	3284*609175	4.64	4.74	0.53	4.86	4.30	0.78	FAL83
26	175		MN3140	1 30	815	04291387*65	4.24	4.13	0.81	4.19	3.57	0.96	FAL83
27	176		MN3140	2 21	847	034*2198765	4.49	4.43	0.73	4.63	4.00	0.95	FAL83
28	177		MN3140	3 17	837	02419*36875	4.35	4.24	0.73	4.29	3.71	0.94	FAL83
29	178		MN3161	1 28	817	0849321*675	4.67	4.82	0.38	4.89	4.29	0.93	FAL83
30	179		MN3161	2 27	847	0493*268175	3.48	3.15	1.20	3.17	2.74	0.96	FAL83
31	180		MN3161	3 22	837	40329*86175	3.62	3.32	1.02	3.17	2.91	0.95	FAL83
32	181		MN3301	0 7	837	29108*74356	3.76	3.29	0.70	3.33	3.43	0.17	FAL83
33	182		MN3302	0 23	815	234109*8756	4.37	4.67	0.56	4.80	4.17	0.91	FAL83
34	183		MN3303	0 10	815	843021*9765	4.92	5.00	0.00	5.00	4.70	0.90	FAL83
35	184		MN3371	0 11	367	1874*309625	4.45	4.27	0.86	4.58	4.27	0.09	FAL83
36	185		MN3373	0 19	813	2198430*765	4.16	4.11	0.85	4.20	3.47	0.56	FAL83
37	186		MN3375	0 16	827	243091*8765	4.58	4.56	0.70	4.77	4.19	0.00	FAL83
38	187		MN4105	1 20	837	42*08931657	4.27	4.15	0.91	4.33	3.90	0.95	FAL83
39	188		MN4105	2 15	837	829041*7365	3.81	3.93	1.18	4.33	3.20	0.93	FAL83
40	189		MN4105	3 22	817	0834921*576	4.28	4.18	0.72	4.20	3.95	0.91	FAL83
41	190		MN4105	4 18	367	8432109*657	4.33	4.44	0.60	4.50	3.78	0.50	FAL83
42	191		MN4110	0 9	847	72198403*56	2.55	1.89	0.87	1.75	1.89	0.89	FAL83
43	192		MN4116	0 11	857	123497085*6	4.37	4.09	0.79	4.13	4.00	0.64	FAL83
44	193		MN4122	0 11	837	4810923*765	3.44	3.18	1.03	3.20	2.64	0.10	FAL83
45	194		MN4123	0 10	857	2941*830657	4.72	4.60	0.66	4.79	4.40	0.90	FAL83
46	195		MN4145	1 26	837	4813290*756	3.86	3.73	1.06	3.90	2.88	0.92	FAL83
47	196		MN4145	2 13	837	4903281*765	4.16	4.23	0.70	4.25	3.23	0.77	FAL83
48	197		MN4154	1 22	837	042*9831756	4.00	3.95	0.64	3.96	3.32	0.70	FAL83

EXHIBIT 2

STATISTICAL DESCRIPTION OF QUANTITATIVE VARIABLES

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN
SIZE	1610	20.60745342	8.75684623	2.00000000	86.00000000	0.21824022
MEAN11	1610	4.12931677	0.54590950	1.37000000	5.00000000	0.01360529
MEAN12	1610	4.02601242	0.71591653	1.08000000	5.00000000	0.01784224
MEDIAN12	1610	4.10199379	0.76191130	1.04000000	5.00000000	0.01898854
MEAN13	1610	3.66124224	0.68517204	1.08000000	5.00000000	0.01707602
REQDPR	1610	0.77300000	0.26391706	0.00000000	1.00000000	0.00657740

EXHIBIT 3

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 1610

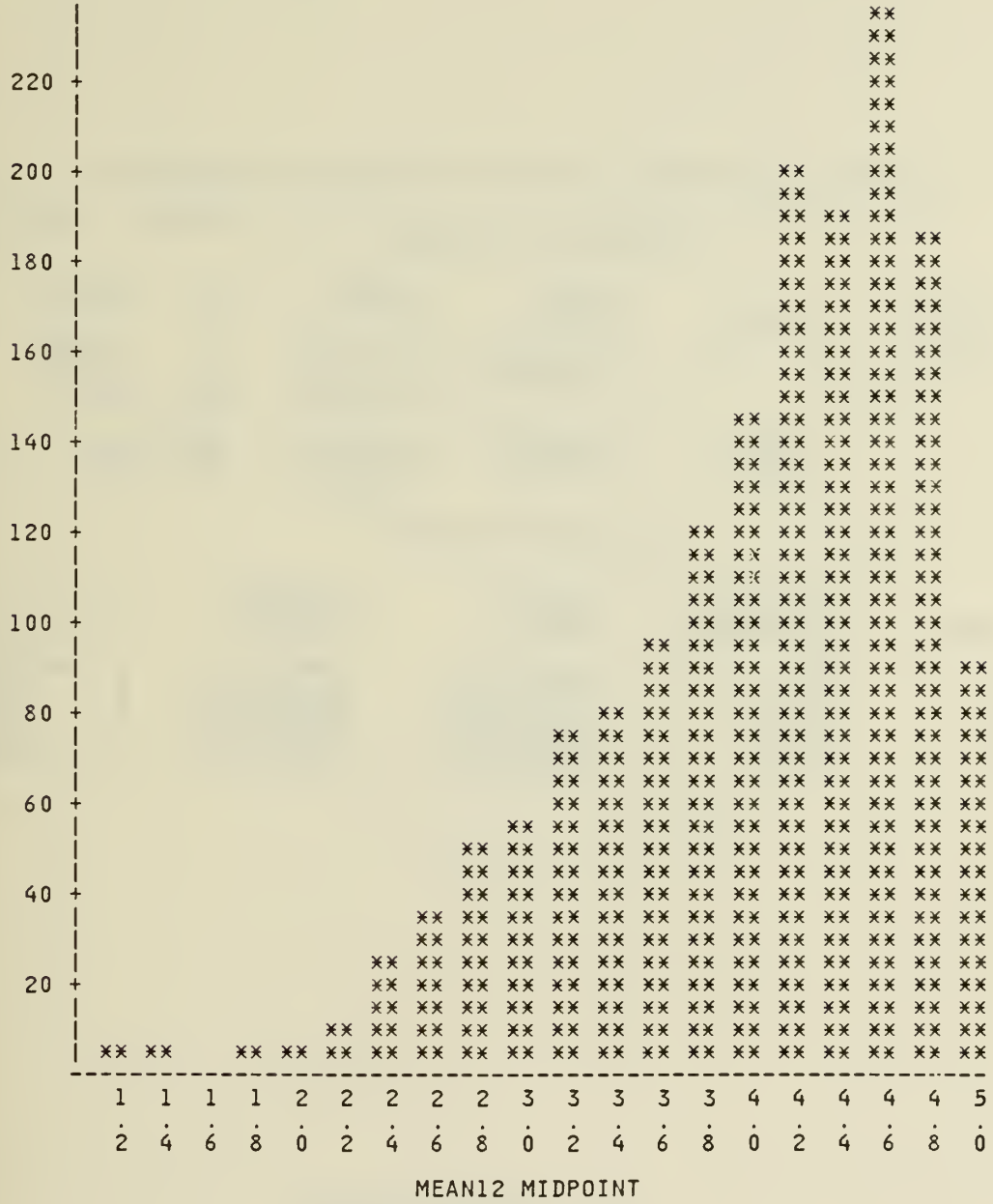
	SIZE	MEAN11	MEAN12	MEDIAN12	MEAN13	REQDPR	YEAR
SIZE	1.00000 0.0000	-0.18710 0.0001	-0.16391 0.0001	-0.14323 0.0001	-0.22566 0.0001	0.37251 0.0001	0.08116 0.0011
MEAN11	-0.18710 0.0001	1.00000 0.0000	0.96684 0.0001	0.95310 0.0001	0.92450 0.0001	-0.25961 0.0001	0.02444 0.3271
MEAN12	-0.16391 0.0001	0.96684 0.0001	1.00000 0.0000	0.98749 0.0001	0.88370 0.0001	-0.23521 0.0001	0.01164 0.6407
MEDIAN12	-0.14323 0.0001	0.95310 0.0001	0.98749 0.0001	1.00000 0.0000	0.87351 0.0001	-0.21968 0.0001	0.01214 0.6264
MEAN13	-0.22566 0.0001	0.92450 0.0001	0.88370 0.0001	0.87351 0.0001	1.00000 0.0000	-0.30934 0.0001	0.04379 0.0790
REQDPR	0.37251 0.0001	-0.25961 0.0001	-0.23521 0.0001	-0.21968 0.0001	-0.30934 0.0001	1.00000 0.0000	0.13151 0.0001
YEAR	0.08116 0.0011	0.02444 0.3271	0.01164 0.6407	0.01214 0.6264	0.04379 0.0790	0.13151 0.0001	1.00000 0.0000

EXHIBIT 4

FREQUENCY DISTRIBUTION FOR MEAN ITEM 12 (N = 1,610)

FREQUENCY BAR CHART

FREQUENCY



REGRESSION OF MEAN ITEM 12 ON ALL QUANTITATIVE VARIABLES

DEP VARIABLE: MEAN12

ANALYSIS OF VARIANCE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB>F
MODEL	4	654.31180	163.57795	1541.110	0.0001
ERROR	1605	170.35940	0.10614293		
C TOTAL	1609	824.67120			
ROOT MSE		0.3257958	R-SQUARE	0.7934	
DEP MEAN		4.026012	ADJ R-SQ	0.7929	
C.V.		8.092271			

PARAMETER ESTIMATES

VARIABLE	DF	PARAMETER ESTIMATE	STANDARD ERROR	T FOR H0: PARAMETER=0	PROB > T
INTERCEP	1	0.46760587	0.06218054	7.520	0.0001
MEAN13	1	0.95000607	0.01262108	75.271	0.0001
SIZE	1	0.002398057	0.001008462	2.378	0.0175
YEAR	1	-0.01140744	0.003666325	-3.111	0.0019
REQDPCNT	1	0.001080501	0.000345340	3.129	0.0018

EXHIBIT 6

ANOVA OF MEAN ITEM 12 BY COURSE AND FACULTY

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEAN12

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	278	541.66375489	1.94843077	9.16
ERROR	1331	283.00744486	0.21262768	PR > F
CORRECTED TOTAL	1609	824.67119975		0.0

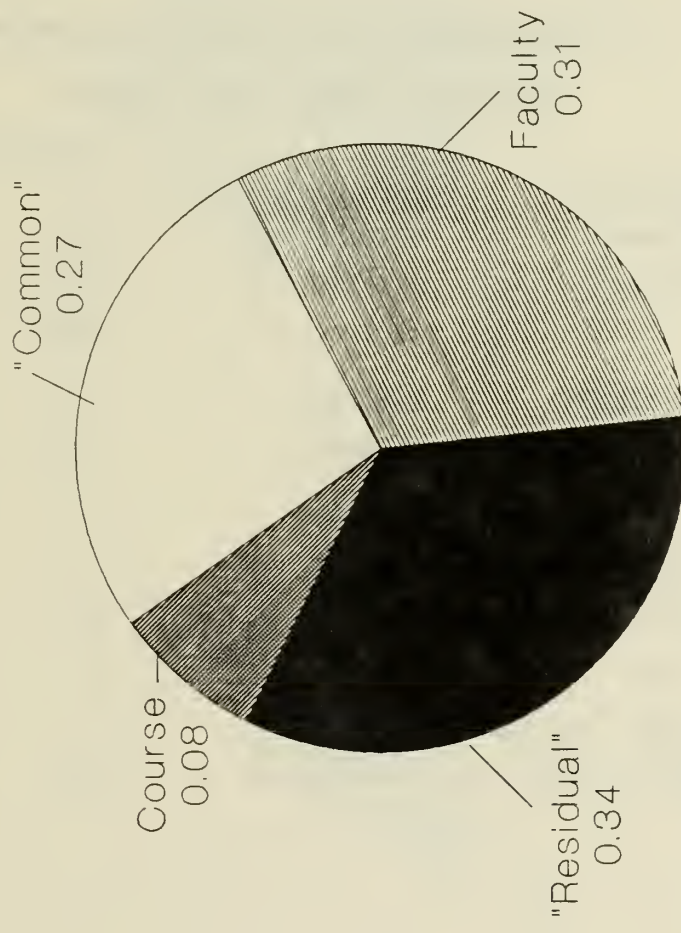
R-SQUARE	C.V.	ROOT MSE	MEAN12 MEAN
0.656824	11.4534	0.46111569	4.02601242

SOURCE	DF	TYPE I SS	F VALUE	PR > F
COURSE	130	287.94416954	10.42	0.0
FACULTY	148	253.71958535	8.06	0.0

SOURCE	DF	TYPE III SS	F VALUE	PR > F
COURSE	128	62.96313651	2.31	0.0001
FACULTY	148	253.71958535	8.06	0.0

EXHIBIT 7

VARIATION IN MEAN ITEM 12 due to Course and Faculty



ANCOVA OF MEAN ITEM 12 BY COURSE AND FACULTY
WITH MEAN ITEM 13 AS A COVARIATE

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: MEAN12

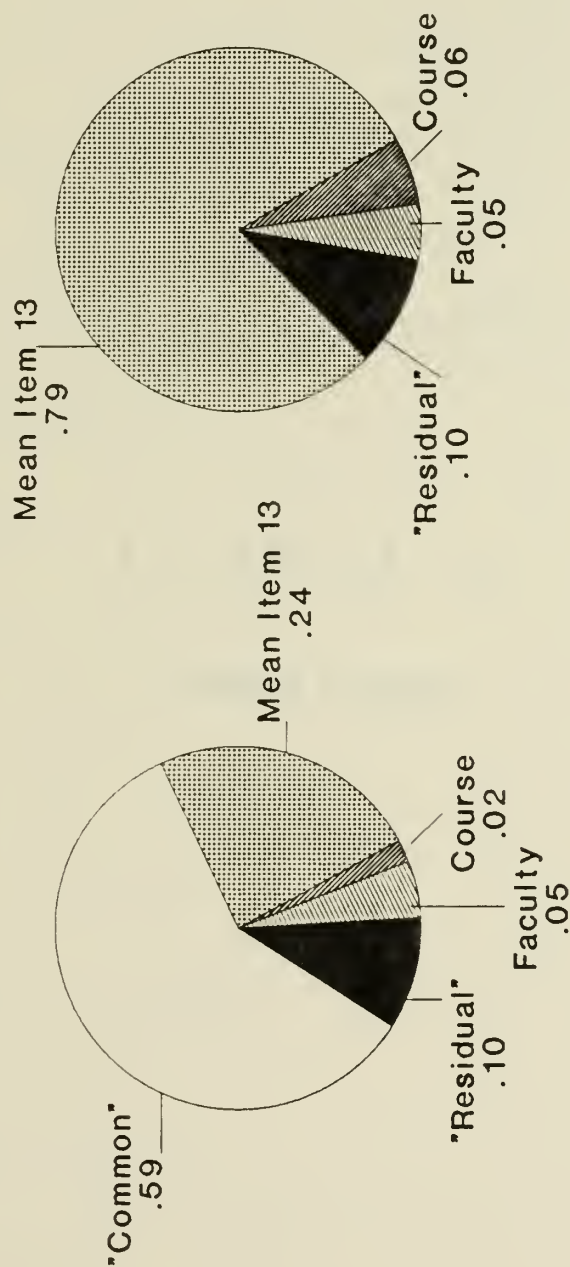
SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	279	738.39508740	2.64657737	40.80
ERROR	1330	86.27611235	0.06486926	PR > F
CORRECTED TOTAL	1609	824.67119975		0.0

R-SQUARE	C.V.	ROOT MSE	MEAN12 MEAN
0.895381	6.3262	0.25469444	4.02601242

SOURCE	DF	TYPE I SS	F VALUE	PR > F
MEAN13	1	651.31623693	10040.45	0.0
COURSE	130	46.44339437	5.51	0.0001
FACULTY	148	40.63545610	4.23	0.0001

SOURCE	DF	TYPE III SS	F VALUE	PR > F
MEAN13	1	196.73133251	3032.74	0.0
COURSE	128	18.89818300	2.28	0.0001
FACULTY	148	40.63545610	4.23	0.0001

VARIATION IN MEAN ITEM 12 due to Course and Faculty with Mean Item 13 as a Covariate



(a)
Independent Effects

(b)
Incremental Effects

A P P E N D I X A

FORTRAN Program


```

//SELECT4 JOB (0597,0828),'SELECT4 FORTRAN',CLASS=A
//*MAIN SYSTEM=SY2
// EXEC VSF2CG
//FORT.SYSIN DD *
  CHARACTER * 5 TRM
  DIMENSION XITEM(16),YITEM(16),ITEM(16),MCURR(10),KCURR(10),XN(16)
  DIMENSION P(5)
  TRM = 'WTR83'
  MSOF = 0
  N = 0
  Y11 = 0.
  YY12 = 0.
  REQ = 0.
  PREQ = 0.
  XREQ = 0.
  DO 3 I = 1, 5
    P(I) = 0.
  3 CONTINUE
  DO 5 I = 1, 16
    YITEM(I) = 0.
    XN(I) = 0.
  5 CONTINUE
  DO 6 I = 1, 10
    KCURR(I) = 0
    MCURR(I) = 0
  6 CONTINUE
  100 READ(5,100,END=300) NSOF, NCURR, REQ, (XITEM(I),I=1,16)
  110 FORMAT(3X,I3,I3,4X,F1.0,16(F1.0))
  9 CONTINUE
  IF(NSOF.LT.140) GO TO 10
  IF(NSOF.EQ.MSOF) GO TO 20
  IF(MSOF.EQ.0) GO TO 19
  XMED = 0.
  IF(XN(12).EQ.0.) GO TO 4
  XN12 = XN(12)
  YY12 = YY12/XN12
  XN2 = XN12/2.
  SUMP = 0.
  DO 2 I = 1, 5
    IF(SUMP.GE.XN2) GO TO 2
    III = I
    SUMP = P(I) + SUMP
  2 CONTINUE
  SUMP = SUMP - P(III)
  XI = FLOAT(III)
  XI2 = XI - .5
  XMED = XI2 + (XN2 - SUMP)/P(III)
  4 CONTINUE
  DO 11 I = 1, 16
    IF(XN(I).EQ.0.) GO TO 11
    YITEM(I) = YITEM(I)/XN(I)
    XN(I) = 0.
  11 CONTINUE
  Y12 = YITEM(12)
  Y13 = YITEM(13)
  YY12 = SQRT(YY12 - Y12*Y12)
  DO 8 K = 1, 11
    Y11 = YITEM(K) + Y11
    YK = 5.
  DO 7 I = 1, 11
    IF(XN(I).EQ.1.) GO TO 7
    IF(YITEM(I).GT.YK) GO TO 7
    YK = YITEM(I)
  7 CONTINUE
  XN(II) = 1.
  IF(II.EQ.10) II = 0
  ITEM(K) = II
  8 CONTINUE
  MAX = 0
  DO 12 I = 1, 10
    IF(KCURR(I).LE.MAX) GO TO 12

```

```

      MAX = KCURR(I)
      NCURR = MCURR(I)
12  CONTINUE
      R = PREQ/XREQ
      XM = XMED
      Y = Y11/11.
      WRITE(1,200) MSOF,N,NCURR,(ITEM(I),I=1,11),Y,Y12,YY12,XM,Y13,R,TRM
200  FORMAT(1X,I3,3X,I2,3X,I3,3X,11(I1),3X,6(F4.2,3X),A5)
      N = 0
      Y11 = 0.
      YY12 = 0.
      REQ = 0.
      PREQ = 0.
      XREQ = 0.
      DO 15 I = 1, 16
      YITEM(I) = 0.
      XN(I) = 0.
15  CONTINUE
      MSOF = NSOF
      DO 16 I = 1, 10
      KCURR(I) = 0
      MCURR(I) = 0
16  CONTINUE
      DO 17 I = 1, 5
      P(I) = 0.
17  CONTINUE
      IF(NSOF.GT.219) GO TO 300
      GO TO 9
19  MSOF = NSOF
20  CONTINUE
      KK = 0
      DO 25 I = 1, 10
      IF(KK.EQ.1) GO TO 25
      IF(MCURR(I).NE.NCURR) GO TO 21
      KCURR(I) = KCURR(I) + 1
      KK = 1
      GO TO 25
21  IF(MCURR(I).NE.0) GO TO 25
      MCURR(I) = NCURR
      KCURR(I) = KCURR(I) + 1
      KK = 1
25  CONTINUE
      N = N + 1
      X12 = XITEM(12)
      IF(X12.LT.1..OR.X12.GT.5.) GO TO 26
      N12 = IFIX(X12)
      P(N12) = P(N12) + 1.
26  CONTINUE
      IF(REQ.NE.0..AND.REQ.NE.1.) GO TO 27
      PREQ = REQ + PREQ
      XREQ = XREQ + 1.
27  CONTINUE
      DO 30 I = 1, 16
      IF(XITEM(I).LT.1..OR.XITEM(I).GT.5.) GO TO 30
      YITEM(I) = XITEM(I) + YITEM(I)
      XN(I) = XN(I) + 1.
      IF(I.EQ.12) YY12 = X12*X12 + YY12
30  CONTINUE
      GO TO 10
300 CONTINUE
      STOP
      END

```

```

/*
//GO.FT05F001 DD DISP=SHR,DSN=MSS.F0597.ROD(WNT83)
//GO.FT01F001 DD SYSOUT=B,DCB=BLKSIZE=80
//

```

A P P E N D I X B

SAS Program


```

CMS FILEDEF SCORES DISK FAL90 SOFDATA A;
CMS FILEDEF NAMES DISK FAL90 SOFNAME B;
CMS FILEDEF MERGE DISK FAL90 SOFMERGE B;
DATA SOFDATA;
  INFILE SCORES;
  INPUT @2 IDSOF $CHAR3.
        @7 NSTUDENT $CHAR3.
        @13 CURR $CHAR3.
        @19 RANKS $CHAR11.
        @33 MEAN11 $CHAR4.
        @40 MEAN12 $CHAR4.
        @47 STD12 $CHAR4.
        @54 MED12 $CHAR4.
        @61 MEAN13 $CHAR4.
        @68 REQD $CHAR4.
        @75 QTRYR $CHAR5. ;
DATA SOFNAME;
  INFILE NAMES;
  INPUT @2 IDSOF $CHAR3.
        @8 IDPROF $CHAR2.
        @13 IDCOURSE $CHAR6.
        @22 SEGMENT $CHAR1. ;
PROC SORT DATA=SOFDATA; BY IDSOF;
PROC SORT DATA=SOFNAME; BY IDSOF;
DATA MERGE;
  MERGE SOFNAME SOFDATA; BY IDSOF;
OPTIONS LINESIZE = 80;
PROC PRINT;
DATA _NULL_;
  SET MERGE;
  FILE MERGE;
  PUT IDSOF $CHAR3.
      +1 IDPROF $CHAR2.
      +1 IDCOURSE $CHAR6.
      +1 SEGMENT $CHAR1.
      +1 NSTUDENT $CHAR3.
      +1 CURR $CHAR3.
      +1 RANKS $CHAR11.
      +1 MEAN11 $CHAR4.
      +1 MEAN12 $CHAR4.
      +1 STD12 $CHAR4.
      +1 MED12 $CHAR4.
      +1 MEAN13 $CHAR4.
      +1 REQD $CHAR4.
      +1 QTRYR $CHAR5. ;

```


A P P E N D I X C

Average Mean Item 12 Responses for Courses

MEAN ITEM 12 FOR EACH COURSE
GENERAL LINEAR MODELS PROCEDURE

MEANS		
COURSE	N	MEAN12
AS1501	17	4.42588235
AS1701	2	4.41500000
AS3501	10	4.03000000
AS3610	18	3.63222222
AS3611	15	4.51466667
AS4601	2	4.09500000
AS4610	2	3.00000000
AS4613	1	3.75000000
CM3001	6	4.40333333
CM3002	5	3.90400000
CM3111	18	3.62777778
CM3112	4	3.13750000
CM3212	1	3.07000000
CM4003	1	4.25000000
CM4502	3	4.41333333
CM4925	7	3.92285714
CO3111	2	2.61500000
IS0123	17	4.64529412
IS1004	4	3.15000000
IS2000	22	3.18409091
IS2100	19	2.91578947
IS2901	16	4.78937500
IS3000	13	3.88230769
IS3020	2	3.27000000
IS3100	3	3.74000000
IS3170	25	3.94760000
IS3171	13	3.78692308
IS3183	45	3.91133333
IS3184	1	4.18000000
IS3186	2	5.00000000
IS3220	10	4.17100000
IS3502	17	3.69294118
IS3503	3	3.82000000
IS4182	22	4.32136364
IS4183	20	4.06450000
IS4184	6	3.94000000
IS4185	28	3.89392857
IS4200	25	3.69440000
IS4300	10	3.92500000
IS4320	1	4.40000000
IS4502	1	4.32000000
IS4925	6	4.49000000
MG3373	1	2.00000000
MM3301	1	4.17000000
MN1111	1	3.54000000
MN1501	3	4.71000000
MN2013	1	4.53000000
MN2031	40	3.31475000
MN2105	2	4.64500000
MN2106	8	4.17625000
MN2111	12	4.28666667
MN2112	9	4.10000000
MN2113	8	4.39000000
MN2114	2	3.51500000
MN2115	1	4.78000000
MN2150	47	4.35170213
MN2155	27	4.32111111
MN2302	18	4.40555556
MN2901	15	4.53000000
MN3001	4	3.18250000
MN3031	1	2.72000000
MN3101	5	4.36200000
MN3104	1	3.03000000
MN3105	73	4.14479452
MN3111	16	3.90187500
MN3114	5	4.76600000
MN3116	2	4.19000000
MN3123	4	4.72750000
MN3140	45	3.77977778
MN3161	46	4.17217391
MN3172	44	3.54204545

MEAN ITEM 12 FOR EACH COURSE
GENERAL LINEAR MODELS PROCEDURE

MEANS		
COURSE	N	MEAN12
MN3301	44	4.09977273
MN3302	7	3.78571429
MN3303	12	4.49833333
MN3304	13	4.48923077
MN3305	12	4.26666667
MN3307	22	3.91954545
MN3310	2	4.16500000
MN3333	58	3.92103448
MN3371	18	4.48555556
MN3372	13	3.30076923
MN3373	7	4.09142857
MN3374	16	3.87625000
MN3375	5	4.59800000
MN3377	11	3.68363636
MN3650	1	5.00000000
MN3760	14	4.17500000
MN3801	6	4.62333333
MN3900	1	5.00000000
MN3902	11	3.37181818
MN3903	4	2.83750000
MN4105	54	4.38962963
MN4106	16	4.34562500
MN4110	15	3.65533333
MN4111	5	3.63900000
MN4112	3	4.28666667
MN4116	4	3.72000000
MN4117	3	4.20666667
MN4119	4	4.40750000
MN4120	1	4.63000000
MN4121	4	4.64250000
MN4122	9	4.42444444
MN4123	4	4.24000000
MN4124	4	4.57250000
MN4125	9	4.42444444
MN4127	4	4.65250000
MN4145	40	3.15875000
MN4151	18	4.10555556
MN4152	16	4.19625000
MN4154	68	3.91176471
MN4155	12	4.19166667
MN4159	12	4.69750000
MN4161	23	4.10130435
MN4162	17	3.96294118
MN4163	16	4.72500000
MN4301	11	4.68818182
MN4302	5	4.70000000
MN4310	10	3.92600000
MN4371	12	4.40750000
MN4372	4	4.65750000
MN4373	8	4.73000000
MN4374	1	4.92000000
MN4500	10	3.98300000
MN4761	14	4.12214286
MN4900	2	4.62500000
MN4904	1	5.00000000
MN4942	1	3.50000000
MN4960	1	4.67000000
MN4970	2	4.80000000

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